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LANL Meteorological Program Self-Assessment 2021 Update

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Acronyms and Abbreviations

Acronym	Definition
ABQ	Albuquerque
ANS	American Nuclear Society
ANSI	American National Standards Institute
ARCON	Atmospheric Transport and Diffusion Code
CAPARS	Consequence Assessment Protective Actions System
CEA	Communications and External Affairs
COTS	Commercially Off The Shelf
DMCC	DOE Meteorological Coordinating Council
DMSC	DOE Meteorological Subcommittee
DOE	Department of Energy
DSA	Documented Safety Analysis
EC	Environmental compliance
EM	Emergency Management
ENV	Environmental
EOC	Emergency Operations Center
EPIcode	Atmospheric Transport and Diffusion Code
ERO	Emergency Response Organization
ES & H	Environmental Safety & Health
FTE	Full Time Equivalent
FY	Fiscal Year
G	Guide
HDBK	Handbook
HOTSPOT	Atmospheric Transport and Diffusion Code
HRRR	High-Resolution Rapid Refresh
HVAC	Heating Ventilation and Air Conditioning
HYRAD	Atmospheric Transport and Diffusion Code
IT	Information Technology
JTA	Job Task Analysis
LANL	Los Alamos National Laboratory
LOI	Line of Inquiry
LA-UR	Los Alamos – Unclassified Report
LIDAR	Light Detection and Ranging
MACCS	MELCOR Accident Consequence Calculation System
MAQ	Meteorology Air Quality
ML	Management Level
MLD	Management Level Determination
MPG	Meteorology Program Guide
NAM	North American Mesoscale Forecast System
NARAC	National Atmospheric Release Advisory Center
NCEP	National Centers for Environmental Prediction
NPH	Natural Phenomena Hazard
NQA	Nuclear Quality Assurance

NWS	National Weather Service
O	Order
ORNL	Oak Ridge National Laboratory
PA	Protective Actions
PV-WAVE	Precision Visuals – Workstation Analysis and Visualization Environment
PWMP	Probable Winter Maximum Precipitation
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
RSS	Root Sum of Squares
RUC	Rapid Update Cycle
SAE	Software and Applications Engineering
SB	Safety Basis
SODAR	Sound Detection and Ranging
SOP	Standard Operating Procedure
SRNL	Savannah River National Laboratory
STD	Standard
TA	Technical Area
VCS	Voluntary Consensus Standard
WETF	Weapons Engineering and Testing Facility
WRF	Weather Research and Forecasting Model

1 Recommended LANL Meteorological Program Improvements

1.1 Overview of 2006 and 2015 DMCC Assist Visits

The DOE Meteorological Coordinating Council (DMCC) conducted an initial LANL Meteorological (Met) Program Assist Visit in August 2006, and several observations and recommendations were shared with LANL management (DMCC 2006). In August 2015, a follow-up Met Program Assist Visit was conducted to determine progress in meeting all the observations and recommendations from the prior Assist Visit (DMCC 2015). During the 9 years between these two Assist Visits, DMCC noted that significant program improvements were made, and these were noted in the 2015 Assist Visit observations and recommendations.

During the 2015 Assist Visit, the LANL Met Program was evaluated relative to the following 8 high-level questions:

- What is the state of the meteorological services provided to its customers?
- What is the quality of meteorological data provided to its customers and is it adequate and available to meet all customer needs?
- What is the quality of atmospheric transport and diffusion modeling provided to its customers and is it applicable to complex wind flow patterns at LANL?
- Are the current and future meteorological service customers being serviced appropriately?
- Are there adequate human resources to meet present and future program customer needs and are they being appropriately leveraged?
- Are existing instrumentation, facilities, and systems adequate to meet present and future customer needs?
- Are LANL meteorological services conducted in an efficient, cost-effective manner?
- Is meteorological data used to ensure safety & health of LANL personnel?

More specific evaluations were performed relative to 23 objectives extracted from the ANSI/ANS-3.11-2015 national standard and 14 objectives associated with consequence assessment and atmospheric transport and diffusion modeling in the consequence assessment element of DOE G 151.1-1.

The 2015 Assist Visit was conducted in four (4) parts:

Part I: In 2006, the Met Program was compared to the 23 performance criteria within a Voluntary Consensus Standard (VCS), ANSI/ANS-3.11-2005(R2010), and the 19 performance criteria associated with consequence assessment element of DOE G 151.1-1, supplemented by draft DOE G 151.1-XY. The team looked at the progress made on each of the 2006 recommendations and provided a status of the present program relative to these monitoring and consequence assessment performance criteria.

The following general performance requirements were evaluated:

- Objectives 1-1 through 1-4: Meteorological monitoring system (4 requirements);
- Objectives 2-1 through 2-3: Siting of meteorological observation instruments (3 requirements);
- Objectives 3-1 through 3-5: Data acquisition system (5 requirements);
- Objectives 4-1 through 4-7: Data management (7 requirements);
- Objectives 5-1 through 5-4: System performance (4 requirements);

- Objectives 6-1 through 6-10: Consequence assessment modeling attributes and integration with emergency response program (10 requirements); and,
- Objectives 6-11 through 6-14: Consequence assessment modeling attributes and integration with offsite authorities (4 requirements).

Part II: The present custodians of the meteorological monitoring program were interviewed to establish the most recent program baseline and the status of its implementation. In addition, visual surveillances of a sample of the instrumentation were performed and evaluated to determine how they met the applicable performance objectives of ANSI/ANS-3.11-2005(R2010).

Part III: The present meteorological data customers were interviewed to determine the level of their satisfaction with the meteorological data products and services and to identify any improvements. Representatives of the following customers were either interviewed or information about the LANL interface was provided by: (1) Safety Basis; (2) Emergency Management; (3) Environmental Compliance; (4) Operations; and (5) Environmental Safety & Health (ES&H).

Part IV: Responses to a questionnaire with 31 Met Program Lines of Inquiry (LOI) in DOE-HDBK-1216-2015 were documented in the Assist Visit report.

The DMCC Assist Visit team concluded that although there are many observations and recommendations, and the program is not fully compliant with ANSI/ANS-3.11-2005(R2010) and the consequence assessment element of DOE G 151.1-1, it is still a very strong and well-managed program. Fulfillment of the current recommendations while at the discretion of LANL management, will result in superior program services to internal and external customers.

1.2 DMCC Assist Visit Observations and Recommendations

The DMCC Assist Visit observations and recommendations from both Assist Visits are related to improving the Met Program. The status of the program improvements to meet the intent of the DMCC Assist Visit recommendations was documented in the 2019 annual self-assessment (LA-UR-19-20818) and the 2020 annual self-assessment (LA-UR-20-25325).

Based on significant improvements in the Met Program since the last DMCC Assist Visit, the addition of human resources, three new meteorological towers and additional meteorological monitoring capability, as well as an independent NQA-1 audit (Ailes 2018), it was determined that another self-assessment should be performed prior to a potential 2022 DMCC follow-up Assist Visit.

Since the 2015 Assist Visit, the DMCC has changed its name to the DOE Meteorological Subcommittee (DMSC). This report will continue to use the original DMCC name until a future Assist Visit is conducted by the DMSC.

Recommendation #1: Increase Meteorological Program Human Resources

2006 Assist Visit Observation	**#06-01**: The scope of the existing meteorological program, especially the vital support required by EM&R, cannot be effectively accomplished with the present manpower allocation. The important Emergency Response Organization (ERO) meteorologist/consequence assessor position, which should be 3-deep, is presently 1-deep. When this individual is ill or on vacation, there is no coverage. This is further exacerbated by the expected learning curve of two individuals who have recently joined the program due to recent retirements.
2006 DMCC Recommendation	**#06-01:** Perform a Job Task Analysis (JTA) of the meteorological program and determine realistic manpower requirements, accounting for program upgrades, to meet all customer needs. Consider increasing FTE count of meteorologists, instrumentation technicians, and software developers to meet the identified human resource requirements.
2015 Pre-Assist Visit Response	Performed in FY15; review with DMCC in August 2015.
2015 DMCC Observation	**#15-01**: A thorough JTA was performed, which showed a FTE count of 2.5. This is slightly low for a site with six meteorological towers and a SODAR actively supporting many LANL customers. The consequence assessment ERO position only has one meteorologist to support it (soon to be two), and this, like all ERO positions, needs three individuals. Based on the extent of work to support all LANL customers and to meet ERO needs, another part-time meteorologist would be needed to provide sufficient human resources.
2015 DMCC Recommendation	**#15-01**: Seek another LANL scientist that could be given collateral duties to fill the third ERO meteorologist position and perform technical tasks that would meet present human resource needs. In addition, summer interns can alleviate some of the workload.

Recommendation #2: Increase Number of Instrumented Meteorological Towers

2006 Assist Visit Observation	**#06-02**: Although there are six meteorological towers, this array of towers may not be sufficient to develop an accurate three-dimensional wind field, which is necessary to drive the complex terrain transport and dispersion model needed to make accurate protective actions for LANL workers and protective action recommendations for the public. Additional, strategically placed meteorological towers and an additional SODAR (i.e., canyon) may need to be deployed to effectively characterize the three-dimensional flow field.
2015 Pre-Assist Visit Response	The meteorology network was assessed in 1994 for adequacy of emergency response protective actions for residents of Los Alamos (i.e., LA-UR-94-3587). It was found to be adequate, since protective actions (PA) in Los Alamos County are made based on neighborhoods and not downwind sectors. Adding meteorology towers in the Los Alamos town site did not change PA decisions. However, a specific assessment of White Rock decisions was not made, but professional judgment indicated that a similar assumption is appropriate for White Rock due to the proximity of the TA-54 tower to White Rock. An evaluation concerning San Ildefonso Pueblo lands has not been made. A study has been proposed for FY16 and over-target funds requested. The two areas of concern are TA-16 (WETF) and TA-54 Area G (White Rock and San Ildefonso lands). The study proposal will be reviewed by the DMCC in August 2015.
2015 DMCC Observation	**#15-02**: The meteorological tower coverage for the CAPARS modeling study proposal was discussed, and two candidate sites were visited. A 20-meter solar-powered battery backup tower would provide coverage for TA-16 since this hazardous facility is outside the 2-km radius of met tower coverage and would add another data point for the CAPARS wind field algorithm. A 10-meter solar-powered battery-backup tower in the canyon near TA-36 would provide insight into canyon-mesa flows and would improve the CAPARS wind field calculation.
2015 DMCC Recommendation	**#15-02**: Without budget constraints, procure two additional meteorological towers, site them nearby the TA-16 facility and in the canyon nearby the TA-36 facility, and then perform a study to determine whether LANL wind fields are adequately characterized.

Recommendation #6: Improve Customer Identification

2006 Assist Visit Observation	**#06-06**: It is difficult to identify some of the customers of the meteorological program since many of the customers access the data from the Weather Machine internet page. Without knowing the customers, it is impossible to periodically meet with them to ensure that their data needs are being met and that their additional data requirements are being identified.
2006 DMCC Recommendation	**#06-06**: Identify customers, based on internet protocol addresses. Meet with customers to ensure that their data needs are being met; consider requesting recharge.
2015 Pre-Assist Visit Response	ENV-ES will pursue a survey through the LANLtoday email system to identify customers. During FY13, computer support resources were not available to identify customers thru IP addresses; this will be considered in FY14. A survey was conducted during FY13 using a survey monkey on the LANL home page. Customers and data usage has been documented.
2015 DMCC Observation	**#15-06**: The DMCC interviewed a wide array of known LANL customers (i.e., EC, EM&R, operations safety, nuclear safety) and is pleased to report that every customer need is satisfied in a timely manner. The FY13 survey (LANL-UR-15-26526) provided a customer baseline. However, it was learned that any LANL employee can download meteorological data from the Weather Machine without identifying itself and thus this customer identity cannot be retrieved for future follow up. Moreover, it is uncertain whether the data is being used properly.
2015 DMCC Recommendation	**#15-03**: Institute a system on the Weather Machine where LANL employees or offsite entities must identify themselves before being allowed to download meteorological data. A brief questionnaire that would require the name and contact information of the user and the intended use of the data would provide more information to determine the customer base.

Recommendation #7: Develop Environmentally-Controlled Data Shed Linkage to Data Logger

2006 Assist Visit Observation	**#06-07**: At all the meteorological monitoring stations, the environmentally controlled shed, which houses the data logging equipment, is cooled by an air conditioner. If the air conditioner fails due to mechanical trouble or due to a loss of power to the shed, there may be equipment failure and data loss until the next surveillance is conducted and the failure is noticed
2006 DMCC Recommendation	**#06-07**: Develop an electronic signal to remotely indicate that the air conditioning in the tower instrument sheds have failed.
2015 Pre-Assist Visit Response	The heater/AC unit at TA-6 has been recently replaced and is in progress for TA-54.
2015 DMCC Observation	**#15-07**: The shed that contained the data logging equipment at TA-6 was surveilled. Currently, there is no method to remotely check the temperature inside the shed with data logging and communications equipment. There is a parameter that is transmitted back to the data technician that shows the real-time shed temperature.
2015 DMCC Recommendation	**#15-04**: Continue to complete the CR-3000 data logger upgrade and installation. Include a check of the data logger temperature parameter into the daily data review procedure to identify HVAC operational failures.

Recommendation #8: Annual Self-Assessments

2006 Assist Visit Observation	**#06-08**: ANSI/ANS-3.11 indicates that existing meteorological monitoring programs should be reviewed periodically for conformance to siting guidance considering evolving program objectives, regulatory requirements, facility operating status, and equipment capabilities. The LANL meteorological program has not had an assessment or self-assessment for many years.
2006 DMCC Recommendation	**#06-08**: Perform an annual self-assessment to assure monitoring is meeting program objectives, regulatory requirements, facility requirements, and equipment status. Third party assessments should be considered on a three-year basis.
2015 Pre-Assist Visit Response	DMCC is scheduled to perform an assist visit in FY15. An annual self-assessment will be implemented in FY16.
2015 DMCC Observation	**#15-08**: A follow-up Assist Visit was performed August 20-21, 2015, and a report will be issued by September 30, 2015. The 31 meteorological program LOIs in DOE-HDBK-1216-2015 were provided to the LANL meteorologist, and the responses will be included in the DMCC report. The DMCC self-assessment documents for monitoring and consequence are available for self-assessments and will be updated in FY16 to include DOE-HDBK-1216-2015 LOIs and additional performance criteria.
2015 DMCC Recommendation	**#15-05**: Continue annual self-assessments of the meteorological monitoring program and consequence assessment at staggered six-month intervals. Consider a DMCC Follow-up Assist Visit in the 2018-2019 timeframe.

Recommendation #9: Improve Meteorological Data Checking Software

2006 Assist Visit Observation	**#06-09**: Data validation, which is performed without a procedure, uses a Commercially Off The Shelf (COTS) program (i.e., PV-WAVE), which is effective in determining if individual parameters are out of range or behaving erratically. This can be improved by coupling it with a screening program of inter-parameter checks (e.g., stability class versus wind speed).
2006 DMCC Recommendation	**#06-09**: Consider developing a data validation procedure and augment the protocol with inter-parameter check screening software. (e.g., stability class versus wind speed).
2015 Pre-Assist Visit Response	This is an opportunity for improvement. However, a long-term data management plan is not yet determined, and spending resources on this action is not considered of added value at this time. The data are reviewed on a daily and weekly basis to identify these kinds of issues.
2015 DMCC Observation	**#15-09**: SOP-5160, “Routine Meteorological Data Processing,” was reviewed and is judged to be sufficient. Additional parameter and inter-parameter checking software is available at other DOE sites and should be reviewed for implementation to improve the data screening process.
2015 DMCC Recommendation	**#15-06**: The meteorological data validation process can be improved with additional parameter and inter-parameter checking software. Contact other DOE sites and review its checks to improve the data screening process.

Recommendation #10: Revise Meteorology Technical Project Plan and QAPP

2006 Assist Visit Observation	**#06-10**: The Quality Assurance Project Plan (QAPP) for the meteorological monitoring project does not adequately describe the program's quality assurance principles. A revision, which is being drafted, should be completed in a timely manner, and compared to ANSI/ANS-3.2, which is recommended in ANSI/ANS-3.11.
2006 DMCC Recommendation	**#06-10**: Update QAPP for ANSI/ANS-3.2 and ANSI/ANSI-3.11.
2015 Pre-Assist Visit Response	This is planned to be done by the end of FY15. The QAPP has been updated, but not the entire ANSI/ANS-3.11 standard has been included; specifically, the instrument uncertainty calculation. It will be reviewed by the DMCC in the August 2015 assist visit.
2015 DMCC Observation	**#15-10**: The QAPP and the Meteorology Technical Project Plan were reviewed with respect to compliance with ANSI/ANS-3.11-2005(R2010) and EPA guidance. In general, both plans provide sufficient information on the program and its management. Small improvements are still needed, which will be outlined in the Assist Visit report.
2015 DMCC Recommendation	**#15-07**: Revise Meteorology Technical Project Plan and QAPP to meet all ANSI/ANS-3.11-2005(R2010) requirements.

Recommended LANL Meteorological Program Improvements

Recommendation #11: Increase Site Inspections of Meteorological Towers and Instrumentation

2006 Assist Visit Observation	**#06-11**: Field surveillances are infrequently conducted at each of the six meteorological towers. In addition, a surveillance procedure and checklist are not in place.
2006 DMCC Recommendation	**#06-11**: Develop a met tower field surveillance procedure and checklist.
2015 Pre-Assist Visit Response	This is planned to be done by the end of FY15. The QAPP has been updated, but not the entire ANSI/ANS-3.11 standard has been included; specifically, the instrument uncertainty calculation. It will be reviewed by the DMCC in the August 2015 assist visit.
2015 DMCC Observation	**#15-11**: ENV-ES-MAQ-405.0, "Meteorology Tower Site Inspections," was reviewed and judged to be adequate. It was learned that field surveillances of the instrumentation is generally performed on a monthly or bi-monthly basis.
2015 DMCC Recommendation	**#15-08**: These surveillances should be performed more frequently for early detection of any instrument malfunctions to avoid unwanted large data losses. The frequency of the instrumentation field surveillances should be increased to at least twice per month, or weekly, if possible.

Recommendation #12: Develop Root Sum of Squares Calculation

2006 Assist Visit Observation	**#06-12**: A Root Sum of Squares (RSS) calculation of system accuracy for each meteorological parameter has not been developed and compared to accuracy standards, as recommended in ANSI/ANS-3.11.
2006 DMCC Recommendation	**#06-12**: Perform a Root Sum of Squares (RSS) calculation of system accuracy for each met parameter.
2015 Pre-Assist Visit Response	Examples of these calculations have been obtained from the DMCC, and an update has been written. DMCC is asked to review as part of the August 2015 assist visit.
2015 DMCC Observation	**#15-12**: The RSS accuracy calculation is being drafted. ORNL has completed its calculation and would be willing to share it.
2015 DMCC Recommendation	**#15-09**: Perform the RSS calculation to ensure that the accuracies of all meteorological parameters meet the criteria in Table 1 of ANSI/ANS-3.11-2005(R2010).

Recommendation #13: Increase Field Calibrations of Meteorological Instrumentation

2006 Assist Visit Observation	**#06-13**: ANSI/ANS-3.11 recommends that field calibrations of meteorological instrumentation be performed on a semiannual basis. Recent LANL meteorological calibration cycle is on the order of two years, which is not frequent enough.
2006 DMCC Recommendation	**#06-13**: Implement six-month cycle for calibration of met towers.
2015 Pre-Assist Visit Response	The calibration frequency has been updated to annual, from bi-annual (see http://www.lanl.gov/community-environment/environmental-stewardship/_assets/docs/qa/meteorology/WES-PLAN-300.pdf) based on manufacturers recommendations. The calibration frequency of wind measurements has been updated to every six months.
2015 DMCC Observation	**#15-13**: ENV-CP-SOP-5131.2, “Calibration, Refurbishment & Maintenance of Meteorology Program Equipment,” was reviewed. It was noted that a semi-annual calibration frequency of six months of the meteorological parameters that are used for atmospheric dispersion meets the ANSI/ANS-3.11-2005(R2010) requirements was established. A QA Review of the meteorological instrument was performed in 2013 (LA-UR-15-26835) and found a few areas of improvement and showed the calibration program was of high quality.
2015 DMCC Recommendation	**#15-10**: Continue to explore opportunities, methods, and resources to calibrate all meteorological parameters at six-month intervals per ANSI/ANS-3.11-2005(R2010).

Recommendation #14: Develop Spare Parts Procedure

2006 Assist Visit Observation	**#06-14**: There is no formal procedure that enables the management of meteorological system spare parts. With only an informal accounting of the spare parts, the risk of running low on vital parts is increased, which could lead to undesirable instrument outages if no replacement parts are available. Overall system redundancy should be addressed.
2006 DMCC Recommendation	**#06-14**: Consider developing a system for managing spare parts. Develop an analysis of met system components to determine areas where there are single points of failure.
2015 Pre-Assist Visit Response	This is an opportunity for improvement that has been partially addressed. It will be completed in FY15.
2015 DMCC Observation	**#15-14**: Spare parts are documented by the meteorological technician using a comprehensive spreadsheet. However, without a formal procedure to account for spare parts inventory on a real-time basis, there is a better chance of not having a key part available when an unexpected failure occurs. In addition, an analysis of which failed parts would result in significant data loss of key meteorological parameters would focus spare part resources.
2015 DMCC Recommendation	**#15-11**: Develop a procedure for managing spare parts. Include an analysis of meteorological system components to determine areas where there are single points of failure.

Recommendation #15: Develop and Implement Training Program

2006 Assist Visit Observation	**#06-15**: A procedure and training program to assist the site-wide user community in the usage of internet-based LANL meteorological data and products has not been developed. This procedure and training program will ensure that all site data users access and apply meteorological data effectively.
2006 DMCC Recommendation	**#06-15**: Consider developing and implementing a procedure and training program on accessing and applying met data and products.
2015 Pre-Assist Visit Response	This is an opportunity for improvement that will be considered during FY16. Some training of ESH managers has been performed in FY14.
2015 DMCC Observation	**#15-15**: A meteorology training program has been initiated.
2015 DMCC Recommendation	**#15-12**: Continue developing and implementing a procedure and training program on accessing and applying meteorological data and products.

Recommendation #16: Perform a 10-Year Meteorological NPH Update Analysis

2015 DMCC Observation	**#15-16**: A 10-year NPH update analysis is required by DOE-STD-1020-2012, which includes the meteorological NPHs of straight-line winds, tornadoes, and extreme precipitation. Studies are being scoped and technical resources are being applied to meet this requirement. A special study is needed to establish the 48-hour Probable Maximum Winter Precipitation (PWMP) using historical LANL precipitation data.
2015 DMCC Recommendation	**#15-13**: Perform a 10-year NPH update analysis for extreme straight-line winds, tornadoes, and extreme precipitation, and develop a 48-hour PWMP for the 2,500-year and 6,250-year return periods.

Recommended LANL Meteorological Program Improvements

Recommendation #17: Perform a CAPARS to NARAC Comparison Analysis

2015 DMCC Observation	**#15-17**: Once the LANL wind field is appropriately characterized, running the CAPARS and NARAC models with and without the new meteorological towers would give good information about the similarities and differences in consequence model results. In addition, running MACCS2, CAPARS, and NARAC would give good information about which model would be best suited for Documented Safety Analyses (DSAs).
2015 DMCC Recommendation	**#15-14**: After the LANL wind field is appropriately characterized and CAPARS is installed, perform a comparison of CAPARS and NARAC to learn similarities and differences between the two consequence assessment models. In addition, run MACCS2 to confirm that it is sufficient for use in DSAs.

Recommendation #18: Resolve SODAR Wind Speed Error

2015 DMCC Observation	**#15-18**: The 100-m SODAR wind speed appears to be too low when compared with the nearby meteorological monitoring tower at that level and the other levels of the SODAR vertical wind structure.
2015 DMCC Recommendation	**#15-15**: If this SODAR wind speed error persists, request support from the manufacturer to troubleshoot problem and then make the appropriate repairs.

Recommendation #19: Revise ABQ NWS Forecasts

2015 DMCC Observation	**#15-19**: Weather forecasts are derived from the Albuquerque National Weather Service office, which may be too general for the LANL site technical areas and not account for mesoscale effects (i.e., thunderstorms, valley-mountain temperature differences). More improved local forecasting is needed.
2015 DMCC Recommendation	**#15-16**: The meteorologists should revise the ABQ NWS forecasts to account for local effects and provide more customized forecasts to each technical area.

Recommendation #20: Determine Wind Data Biases

2015 DMCC Observation	**#15-20**: The TA-54 tower wind vane was in direct alignment with the tower boom under prevailing wind conditions. This could potentially affect the accuracy of the wind speed. Boom orientation should be away from prevailing wind directions.
2015 DMCC Recommendation	**#15-17**: Examine wind data from all towers to determine if a systematic bias is introduced by the tower boom-wind sensor alignment.

Recommendation #21: Investigate NCEP prognostic wind field sources and link to CAPARS

2015 DMCC Observation	**#15-21**: CAPARS only has a diagnostic capability. In order to upgrade to prognostic for forecasting plume positions, a NWS prognostic wind field needs to be ingested.
2015 DMCC Recommendation	**#15-18**: Investigate NCEP prognostic wind field sources and link to CAPARS.

2 Summary of Current Program Improvements Since 2015 DMCC Assist Visit

An annual self-assessment was conducted to determine the extent that the Met Program at LANL has addressed the recommendations from the 2015 DMCC Assist Visit. The last self-assessment was conducted in 2020 and documented in LA-UR-20-25325.

It was noted that LANL management has actively addressed many of the open DMCC observations and recommendations, in recognition that these will improve all aspects of the Meteorology Program. Accordingly, many program improvements since the 2015 DMCC Assist Visit have been implemented and each of these will improve the support that the Meteorology Program provides to its LANL customers.

Column 2 of Table 1 shows how the present implementation has improved the Meteorology Program's capacity to meet the program improvement goals, while Column 3 discusses the improvements and identifies future initiatives.

Table 1. Implementation of DMCC Assist Visit Recommendations

DMCC Recommendation	Present LANL Met Program Implementation Status	Present Improvements and Future Initiatives
#15-01: Perform a JTA of the meteorological program and determine realistic manpower requirements, accounting for program upgrades, to meet all customer needs. Consider increasing FTE count of meteorologists, instrumentation technicians, and software developers to meet the identified human resource requirements.	After the recent addition of a meteorologist and an instrument technician, the Met Program employs: • Two meteorologists, • Two instrument technicians (one full-time, one part-time), and • Part-time data steward.	An NQA-1 audit was performed in September 2018. The auditor was assessing the Met Program's support to Safety Basis, Emergency Management, Environmental Compliance, Operations, High Explosives and other LANL organizations. Part of this audit involved a JTA, and it was determined that an additional meteorologist and an additional technician was needed to meet the meteorology program support to its LANL customers. In November 2019, the Met Program added a meteorologist and an instrumentation technician to support the increase of scope of the Met Program including the addition of three meteorological stations funded by Safety Basis (SB).

Summary of Current Program Improvements Since 2015 DMCC Assist Visit

DMCC Recommendation	Present LANL Met Program Implementation Status	Present Improvements and Future Initiatives
#15-02: Without budget constraints, procure two additional meteorological towers, site them nearby the TA-16 facility and in the canyon nearby the TA-36 facility, and then perform a study to determine whether LANL wind fields are adequately characterized.	Three new 10-meter meteorological towers funded by SB were installed at strategic locations near TA-16, TA-54, and TA-63. The towers include multiple wind instruments to improve data accuracy and data completeness. The towers include the RM Young 05305 & 27106T mechanical anemometers, an RM Young 81000 sonic anemometer, and a Campbell Scientific CSAT3B sonic anemometer. These three new towers will substantially improve the characterization of the complex LANL wind field by the CAPARS model for Emergency Management and SB.	Two portable 10-meter towers purchased by Safety Basis will be used for gathering additional data across LANL to support current and future operations.
#15-06: Institute a system on the Weather Machine where LANL employees or offsite entities must identify themselves before being allowed to download meteorological. A brief questionnaire that would require the name and contact information of the user and the intended use of the data would provide more information to determine the customer base.	The internal Weather Machine requires the LANL employee to enter a proper e-mail address before downloading any weather data for information or analytical purposes. The list of e-mail addresses is accessible by the Met Program on an administration page on the Weather Machine.	The external Weather Machine is in the process of being converted to the same version as the internal Weather Machine, which will ask for an e-mail address prior to downloading data. This projected is estimated to be completed by the end of FY22.
#15-07: Continue to complete the CR-3000 data logger upgrade and installation. Include a check of the data logger temperature parameter into the daily data review procedure to identify HVAC operational failures.	All the dataloggers have been upgraded to the CR-3000 since 2016 and the three new towers started with the CR-3000 dataloggers. In the public tables of the datalogger programs, the datalogger panel temperature is available to identify HVAC failures in all the instrument sheds.	All future meteorological monitoring stations will use a CR-3000 datalogger, which is superior to the prior dataloggers that were in place, with the ability to provide surrounding area temperature both real-time and historical temperature data, if programmed.

Summary of Current Program Improvements Since 2015 DMCC Assist Visit

DMCC Recommendation	Present LANL Met Program Implementation Status	Present Improvements and Future Initiatives
#15-08: Continue annual self-assessments of the meteorological monitoring program and consequence assessment at staggered six-month intervals. Consider a DMCC Follow-up Assist Visit in the 2018-2019 timeframe.	There was an NQA-1 audit conducted in September 2018 to determine the appropriate Quality Assurance (QA) requirements for the meteorology program and to evaluate the Management Level Determination (MLD) for hardware and software risk levels. Self-assessments were conducted in 2019 and 2020 to provide updates to the DMCC Assist Visit recommendations in 2015. The self-assessments showed significant progress in closing out the 2015 Assist Visit open items.	The findings of the NQA-1 audit that was conducted in September 2018 showed that the meteorology program was a Management Level (ML) 3 program which indicated it was of critical importance. The Met Program is exploring the possibility of having the DMSC perform an external Assist Visit in FY22 or FY23.
#15-09: The meteorological data validation process can be improved with additional parameter and inter-parameter checking software. Contact other DOE sites and review its checks to improve the data screening process.	The new meteorological data management system has provided the Met Program an additional tool to determine when data is out of range or inconsistent with established climatic conditions, but further development from the Software and Applications Engineering (SAE) division is needed. The Met Program staff visited the Savannah River National Laboratory (SRNL) in July 2019 to share information on their programs. That meeting included a review of their unique and high-level data screening processes.	The meteorological data validation process has been improved, which will enhance data quality and completeness. The procedures EPC-CP-AP-0402, Routine Meteorological Data Processing and EPC-CP-AP-0409, Data Logger Software Quality Revision Control, were updated in 2021 and will be revised every three years.
#15-10: Revise Meteorology Technical Project Plan and QAPP to meet all ANSI/ANS-3.11-2005(R2010) requirements.	The Technical Project Plan (EPC-CP-TPP-MetM) was replaced with a Program Implementation Plan (EPC-CP-PIP-0401) in February 2021. ENV-CP-SOP-5131 was divided into two procedures for more effective implementation and tracking. EPC-CP-SOP-5132 covers wind sensors and EPC-CP-SOP-5135 covers temperature sensors. EPC-CP-SOP-5100 was divided to create EPC-CP-SOP-5101 to cover tilt tower operation and maintenance.	The PIP will be revised every three years. All procedures were updated during FY21.

Summary of Current Program Improvements Since 2015 DMCC Assist Visit

DMCC Recommendation	Present LANL Met Program Implementation Status	Present Improvements and Future Initiatives
#15-11: These surveillances should be performed more frequently for early detection of any instrument malfunctions to avoid unwanted large data losses. The frequency of the instrumentation field surveillances should be increased to at least twice per month, or weekly, if possible.	The instrument technicians perform weekly meteorology tower site surveillances to identify instrument problems and improve the chances of early detection of instrument malfunction and minimization of lost data (EPC-CP-QP-0405). The more frequent surveillances have improved early detection of instrumentation failures which enhances meeting data recovery and completeness goals.	The EPC-CP-QP-0405, Meteorology Monitoring Site Inspections, procedure was updated in 2021 and will be revised every three years.
#15-13: Continue to explore opportunities, methods, and resources to calibrate all meteorological parameters at six-month intervals per ANSI/ANS-3.11-2005(R2010).	Based on ANSI/ANS-3.11-2015 and manufacturer recommendations, anemometers are calibrated every six months, temperature sensors annually, and solar radiation sensors every five years. LANL operational experience has not shown a need to increase the calibration frequency of other instruments.	Calibration frequencies will remain the same. **Note:** Although calibration frequencies will not be altered (i.e., calibrate temperature sensors semiannually), this does affect dispersion modeling applications since temperature difference is not used to type turbulence.
#15-14: Develop a procedure for managing spare parts. Include an analysis of meteorological system components to determine areas where there are single points of failure.	The procedure EPC-CP-AP-0410, LANL Meteorology Monitoring Program Critical Spare Components Classification Administration & Control, was created in 2021.	EPC-CP-AP-0410 will be revised every three years.
#15-15: Continue developing and implementing a procedure and training program on accessing and applying meteorological data and products.	The internal Weather Machine is updated, but needs further development from SAE on the modernization of the website. The external Weather Machine is expected to be updated in FY22, but will also need further development.	Developers in the Communication and External Affairs (CEA) division will be updating the layout of the Weather Machine in FY 22. When SAE and CEA completes all developments, a training program will be established. Accessing and applying data products on the Weather Machine will be included in the update to the Meteorological Monitoring Plan (LA-UR-14-23378).

Summary of Current Program Improvements Since 2015 DMCC Assist Visit

DMCC Recommendation	Present LANL Met Program Implementation Status	Present Improvements and Future Initiatives
#15-16: Perform a 10-year NPH update analysis for extreme straight-line winds, tornadoes, and extreme precipitation, and develop a 48-hour PWMP for the 2,500-year and 6,250-year return periods.	LA-UR-15-29420 provides LANL engineers with the most recent input on extreme precipitation natural phenomena hazards to meet its DOE-STD-1020-2016 design requirements. Further analysis is not expected to be needed for several more years.	In May 2020, an extreme precipitation analysis was developed for LANL EPC-CP Storm Water Permitting/Compliance relative to storm water management, flooding calculations, and other civil engineering applications (LA-UR-20-23488).
#15-18: If this SODAR wind speed error persists, request support from the manufacturer to troubleshoot problem and then make the appropriate repairs.	The SODAR wind speed error has been resolved. In discussions with the SODAR manufacturer (Scintec) in 2016, the wind speed error was assumed to be a result of the infrequent sampling period of the SODAR (i.e., 1 measurement every 11 minutes) compared to the more frequent tower sampling (i.e., 1 measurement every 3 seconds).	A Light Detection & Ranging (Lidar) was purchased in FY21 to improve wind speed measurements aloft. Additionally, to measure temperatures aloft, a radiometer was purchased in FY21. The Lidar and radiometer are estimated for installation and integration in FY22.
#15-19: The meteorologists should revise the ABQ NWS forecasts to account for local effects and provide more customized forecasts to each technical area.	In 2019, the Meteorology Program concurred that the ABQ NWS forecasts do not properly represent the complex terrain of Los Alamos based on informal observations. Other available fine-scale forecast models (e.g., NAM-3 km, HRRR, and WRF) are used to improve forecasting wind shifts and snowfall amounts.	ABQ NWS forecasts of wind shifts, and snowfall amounts have been improved using National Centers for Environmental Predictions (NCEP) products including NAM-3, HRRR, and WRF. The available WRF data are produced from external sources, which does not allow the model to be configured to account for the local complex terrain. The Met Program is in the early stages of developing a local WRF.
#15-20: Examine wind data from all towers to determine if a systematic bias is introduced by the tower boom-wind sensor alignment.	Tower shadowing was evaluated in 2016 (LA-UR-16-24130). The results showed there is no shadowing of the instruments by the towers.	No further evaluation is expected.

Summary of Current Program Improvements Since 2015 DMCC Assist Visit

DMCC Recommendation	Present LANL Met Program Implementation Status	Present Improvements and Future Initiatives
#15-21: Investigate NCEP prognostic wind field sources and link to CAPARS.	Informal observations of NCEP prognostic wind field sources have been used to improve ABQ NWS wind forecasts (e.g., NAM-3, HRRR, and WRF).	Wind profilers from the Rapid Update Cycle (RUC) forecast model provides semi-prognostic wind fields to CAPARS, but higher temporal and spatial resolution forecast modeling is needed. The development of a local WRF would improve the prognostic wind fields and could be implemented into CAPARS.

3 Conclusions

This self-assessment, documented in Table 1, has shown that there has been continued significant progress achieved in meeting the intent of the 21 recommendations from the 2015 DMCC Assist Visit. Every year after the Assist Visit, the LANL Met Program has improved, mainly by addressing the recommendations in the Assist Visit report. The Met Program management should continue to strive to apply its limited resources and seek to acquire additional human capital and physical resources to meet the dynamic needs of its growing sitewide customer base. This includes additional upgrading of the hardware and software elements of the Met Program and implementation of its operational procedures and QAPP to ensure it will consistently meet important present program requirements, as well as anticipated future requirements. These improvements have been summarized in the "present improvements and future initiatives" column in Table 1.

In 2021, the DMCC published the DOE Meteorological Program Guide (MPG) to provide guidance on establishing an effective meteorological program and as a tool for the DOE field offices and national laboratories to determine the size and scope of its programs. The MPG provides worksheets to help scale a meteorological program based on 10 different functions and capabilities. Appendix A has been included in this self-assessment to document the evaluation for the LANL Met Program. LANL received a score of 26, which represents the high end of a moderate-sized program that can be staffed with at least one on-site meteorologist, but preferably two meteorologists. This is consistent with the current staffing level.

In no specific order, it is recommended that LANL management focus on the following 11 tasks in FY22 and beyond, and prioritize its implementation based on current and other resources it may receive from its LANL customers:

1. Evaluate the current Met Program staffing to determine if it meets growing LANL customer needs
2. Undertake additional improvements to QAPP procedures to enhance day-to-day operations
3. Develop a procedure and training program
4. Bring Lidar to an operational state and integrate it into the Met Program services
5. Continue implementing a local WRF capability to improve LANL weather forecasting services
6. Complete the external Weather Machine modifications
7. Develop additional concepts to effectively interact with the LANL customer base and work with LANL IT on further Weather Machine improvements
8. Revise the RSS calculation to account for any system component changes, inclusive of the three new meteorological towers
9. Develop a 10-year NPH update analysis for extreme straight-line winds and tornadoes, if requested
10. Seek funding for implementation of CAPARS mesa-canyon wind field study
11. Acquire new NCEP data sources to assist the emergency management organization

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Appendix A: Evaluation of the Scope and Size of the Los Alamos National Laboratory Meteorological Program

Capability #1: Access to Local Area and Regional Weather Data

Degree of Scope
0: No local area and regional weather data required.
1: Local area and regional weather data required. NWS data will be used.
2: Local area and regional weather data required. Blend of scope between 1 and 3.
3: Local area and regional weather data required. NWS and subscription-based provider will be used.
4: Local area and regional weather data required. Blend of scope between 3 and 5.
5: Local area and regional weather data required. Site will operate and maintain this equipment in conjunction with using data from the NWS.

LANL 2021 Meteorological Program Status: The LANL meteorological program has access to local area and regional NWS information and uses a provider of NWS information.
LANL Score: 3

Capability #2: Number of Onsite Instrumented Meteorological Tower(s)

Examples: Mesonet of 10-meter weather towers, mesonet to include tall towers

Degree of Scope
0: No on-site weather data required.
1: On-site weather data required. NWS data is available and will be used.
2: On-site weather data required. 1 to 3 stations will be operated and maintained.
3: On-site weather data required. 4 to 10 stations will be operated and maintained.
4: On-site weather data required. 11 to 20 stations will be operated and maintained.
5: On-site weather data required. 21 or more stations will be operated and maintained.

LANL 2021 Meteorological Program Status: LANL has four operating instrumented meteorological towers at mesa locations (TA-06, TA-49, TA-53, and TA-54) and one operating meteorological tower in a canyon location (Mortandad). In addition, three additional mesa instrumented towers have been installed and are undergoing functional testing. All these towers are being maintained by full time and part time instrument specialists.
LANL Score: 3

Appendix A: Evaluation of the Scope and Size of the Los Alamos National Laboratory Meteorological Program

Capability #3: Upper Air Data Collection

Examples: SODAR, LIDAR, Radiosondes

Degree of Scope
0: No upper-air weather data required.
1: Upper-air weather data required. NWS data will be used.
2: Upper-air weather data required. Blend of scope between 1 and 3.
3: Upper-air weather data required. NWS and subscription-based provider will be used.
4: Upper-air weather data required. Blend of scope between 3 and 5.
5: Upper-air weather data required. Site will operate and maintain this equipment in conjunction with using data from the NWS.

LANL 2021 Meteorological Program Status: Due to the complex terrain at LANL, upper air data is required for emergency management and wildland fire management. Emergency management uses a three-dimensional mass-consistent transport and diffusion model, CAPARS, which requires upper air meteorological data. The meteorological program has three instrumented towers that measure meteorological data at heights up to 46 meters and one tower that monitors up to 92 meters. In addition, a remote-sensing SODAR which measures meteorological parameters to a height of 800 meters is operational and a LIDAR is being procured.
LANL Score: 4

Capability #4: Other Data Collection

Examples: Lightning Detection, Ceilometers

Degree of Scope
0: No other weather data required.
1: Other weather data required. NWS data will be used.
2: Other weather data required. Blend of scope between 1 and 3.
3: Other weather data required. NWS and subscription-based provider will be used.
4: Other weather data required. Blend of scope between 3 and 5.
5: Other weather data required. Site will operate and maintain this equipment in conjunction with using data from the NWS.

LANL 2021 Meteorological Program Status: The LANL Met Program provides lightning strike data using information available from the NWS. The Met Program does not have a ceilometer to assist helicopters and general aviation with visibility needs. However, once the Lidar is operational, this general aviation and helicopter need can be met.
LANL Score: 1

Capability #5: Forecast Model Products

Examples: NWS, Accu-Weather, Pivotal Weather, Weather Bell, WRF, HRRR

Degree of Scope
0: No forecast model products required.
1: Forecast model products required. NWS data will be used.
2: Forecast model products required. Blend of scope between 1 and 3.
3: Forecast model products required. NWS and subscription-based provider will be used.
4: Forecast model products required. Blend of scope between 3 and 5.
5: Forecast model products required. Site will operate and maintain a local forecast model.

LANL 2021 Meteorological Program Status: The LANL meteorologists use a variety of NWS information for its weekly weather forecasts and occasionally avails itself to some subscription-based products.
LANL Score: 2

Capability #6: Atmospheric Dispersion Model(s)

Examples: HOTSPOT, EPIcode, NARAC, CAPARS, HYRAD

Degree of Scope
0: No dispersion model products required as part of the Meteorology Program.
1: Dispersion model products required. Gaussian model will be used. Minimal hazards present.
2: Dispersion model products required. Blend of scope between 1 and 3.
3: Dispersion model products required. Gaussian model used with NARAC as follow-on. Moderate hazards present.
4: Dispersion model products required. Blend of scope between 3 and 5.
5: Dispersion model products required. Site will operate and maintain a local dispersion model(s) with access to NARAC. Significant hazards present.
Note: This area could be the responsibility of another group at a Field Element such as the emergency response program. Consult with leadership on the specific responsibilities for your Field Element.

LANL 2021 Meteorological Program Status: Although there is a capability to execute dispersion models within the LANL meteorological program, the dispersion modeling capability at LANL resides in the emergency management and safety basis organizations. The meteorological program has acquired the ARCON96 code, has performed the SQA, and used it to support a safety basis project. The Met Program provides the data that is used by the LANL dispersion modelers. The Met Program has the skill sets to perform dispersion modeling.
LANL Score: 1

Appendix A: Evaluation of the Scope and Size of the Los Alamos National Laboratory Meteorological Program

Capability #7: Dispersion Modeler(s)

Examples: Trained EOC staff, NARAC, On-site meteorologist

Degree of Scope
0: No dispersion model products required as part of the Meteorology Program.
1: Dispersion modeler required. Gaussian model will be used. Minimal hazards present. Trained Emergency Operations Center (EOC) staff.
2: Dispersion modeler required. Blend of scope between 1 and 3.
3: Dispersion modeler required. Gaussian model used with NARAC as follow-on. Moderate hazards present.
4: Dispersion modeler required. Blend of scope between 3 and 5.
5: Dispersion modeler required. Site will operate and maintain a local dispersion model(s) with access to NARAC. Significant hazards present.
Note: This area could be the responsibility of another group at a Field Element such as the emergency response program. Consult with leadership on the specific responsibilities for your Field Element.

LANL 2021 Meteorological Program Status: Although there is a capability to execute dispersion models within the LANL meteorological program, the dispersion modeling capability at LANL resides in the emergency management and safety basis organizations. The Met Program has acquired the ARCON96 code, has performed the SQA, and used it to support a safety basis project. The Met Program provides the data that is used by the LANL dispersion modelers.
LANL Score: 1

Capability #8: Weather Forecaster(s)

Examples: NWS, Weather Channel, Accu-Weather, on-site meteorologist

Degree of Scope
0: No weather forecast required.
1: Weather Forecasts required. NWS data will be used.
2: Weather Forecasts required. Blend of scope between 1 and 3.
3: Weather Forecasts required. NWS and subscription-based provider will be used.
4: Weather Forecasts required. Blend of scope between 3 and 5.
5: Weather Forecasts required. An on-site meteorologist will be used for site specific forecasts and information. Routine and frequent access is required.

LANL 2021 Meteorological Program Status: The LANL meteorologist provides weather forecasts for each upcoming week and detailed short-term forecasts during periods of inclement weather that supports the emergency management organization.
LANL Score: 4

Capability #9: Information Technology Infrastructure

Examples: Field Element IT resources, on-site IT resources, servers, high-performance computing

Degree of Scope
0: No staffing required. All functions provided by another group.
1: Staffing required. Field Element IT resources.
2: Staffing required. Blend of scope between 1 and 3.
3: Staffing required. Field Element IT resources with assistance from other local staff.
4: Staffing required. Blend of scope between 3 and 5.
5: Staffing required. Significant IT resources for the collection, processing, distribution, and storage of data; forecast model infrastructure, dispersion model infrastructure.
Note: This area could be the responsibility of another group at a Field Element such as the IT Department. Consult with leadership on the specific responsibilities for your Field Element.

LANL 2021 Meteorological Program Status: The LANL Met Program is supported by SAE for the collection, processing, distribution, and storage of data with respect to placing the quality-assured data on the Weather Machine where it can be accessed by other LANL organizations.
LANL Score: 3

Capability #10: Meteorological Program Staffing

Examples: On-site meteorologist, Meteorological and Electronics Technicians, IT resources, Administrative

Degree of Scope
0: No staffing required. All functions provided by another group or contract.
1: Staffing required. NWS data will be used.
2: Staffing required. Blend of scope between 1 and 3.
3: Staffing required. An on-site meteorologist and technician. Using Field Element IT and Administrative resources.
4: Staffing required. Blend of scope between 3 and 5.
5: Staffing required. A full Meteorological Program which will include multiple on-site meteorologists; Technicians to maintain and operate equipment; IT resources for the collection, processing, distribution, and storage of data; Administrative support to maintain a functioning team.

LANL 2021 Meteorological Program Status: The LANL Met Program has 2 full-time advanced degreed meteorologists, 1.5 instrument technicians, a part-time data reviewer, and some IT support.
LANL Score: 4

Appendix A: Evaluation of the Scope and Size of the Los Alamos National Laboratory Meteorological Program

Scaling the Meteorological Program

There are three program scale recommendations, each based on a specific degree of scope range:

Minimum Scale (Degree of Scope: 0 to 10): Minimum capability required. Most of all functions are provided by another group or contract. No significant need for an on-site program.

Moderate Scale (Degree of Scope: 11 to 30): Moderate capability required. Some functions could be provided by another group or contract. There is a need for a small to medium sized on-site program. At least one on-site meteorologist is required.

Significant Scale (Degree of Scope: 31 to 50): Significant capability is required. Functions will be accomplished by on-site personnel. Significant need for an on-site program. Two meteorologists and support staff are required.

The LANL meteorological program score is 26, as shown in Figure 1, which represents a moderate scale that can be staffed by a medium sized on-site program with at least one on-site meteorologist, but preferably two meteorologists. This is consistent with current staffing level.

If your Field Element needs these Meteorological Program Capabilities	What Degree of Scope does your Field Element Need? (circle the appropriate degree for each Capability)					
Access to Local Area Weather Data	0	1	2	**3**	4	5
Onsite Instrumented Meteorological Tower(s)	0	1	2	**3**	4	5
Upper Air Data Collection	0	1	2	3	**4**	5
Other Necessary Weather Data Collection	0	**1**	2	3	4	5
Local or NWS Forecast Model Products	0	1	**2**	3	4	5
Dispersion Model(s)	0	**1**	2	3	4	5
Dispersion Modeler(s)	0	**1**	2	3	4	5
Weather Forecaster	0	1	2	3	**4**	5
IT Infrastructure	0	1	2	**3**	4	5
Meteorological Support Staff	0	1	2	3	**4**	5
	TOTAL (sum up the rows)			**26**		

Figure 1. LANL Meteorological Program Scoring.